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ON THE PERFORATIONS OF MARINE ANIMALS.

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In former papers* special groups of marine forms which perforate have been dealt with. On the present occasion a general sketch of the subject as represented by the various types of invertebrate marine animals which bore in rocks, shells, sand, and other media will be given. The burrowing of marine forms on our shores is a familiar feature to every zoologist. Moreover, scarcely a dead shell can be dredged from the sea-bed that does not present perforations of boring sponges, the slightest force, in well-marked cases, sufficing to break the thin superficial crust concealing the yellowish substance of the sponge in the interior. Multitudes of living Oyster-shells are affected in the same manner, so that the Whitstable Oyster Company and others have been greatly concerned about their depredations, which, however, are not on the whole very serious. Further, these perforating sponges often perform their work of destruction in the most regular and beautiful manner, leaving arborescent patterns with necklace-like dilatations, or a branching pattern like a Gorgonian, to mark their progress in the shell. In the same way the surface of the limestone rocks of the southern shores is riddled with these sponges (*Cliona*). So far as at present known, sponges bore only in calcareous substances, *viz.* in limestones, shells, nullipores, and corals, but their exact method of operating is still involved in mystery. Prof. R. Grant seems to have been one of the first to notice that *Cliona* formed its own tunnels, and Duvernoy followed him in describing a foreign species. Nardo,[*] again, subsequently gave an account of the perforations of the shells of mollusks, and Michelin further pointed out the dendritic pattern of such excavations. McCalla (1849) also knew that *Cliona* was destructive to shells. Dr. Bowerbank, the able author of the 'British Sponges,' held that they never perforated either rocks or shells, but only took possession of cavities bored by other forms, and that he had found the sponges only partially filling the chambers in the calcareous rocks on the southern coast. Some hold that the soft animal jelly or protoplasm of the sponge is the agent, while others, such as the late Albany Hancock, maintain that it bores by aid of its spicules. One or two, again, like Dr. Bowerbank, have insisted that the sponges do not perforate, but inhabit the galleries of other forms. Thus, some years ago, an able zoologist considered that the so-called boring sponges only occupied the tubes of annelids, and forwarded many specimens with a view to substantiate this opinion. From dredgings off the Channel Islands a very thin shell (lower valve of *Anomia ephippium*), in which translucent medium a *Cliona* had established itself, was forwarded to the zoologist. When held up to the light the beautiful dendritic patterns made by the sponge were clearly outlined, the oscula of the sponge, moreover, projecting from the widened areas. Now this shell was so thin (much thinner than that of *Placuna placenta*) that no known annelid could form a lodgment in it. The zoologist did what, perhaps, was most judicious, *viz.* avoided all subsequent allusion to the matter. A considerable time ago the subject was investigated by Nassonow,[†] who cultivated young boring sponges on thin transparent calcareous lamellæ. The larvæ, after a free stage, settled on the plates, a rosette-like mark appeared, and the sponge gave off thin processes, which passed into the substance of the plate and followed the contour lines of the rosette. This penetration happened

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* Ann. Nat. Hist. 4th ser. vol. ii. pp. 276–295, plates 18–20, October, 1868; and 'Marine Invert. and Fishes of St. Andrews,' pp. 58–60, 1875.

[*] 'Atti degli Scienziati Italiani,' p. 161, Pisa, 1839.

[†] Zeitsch. f. Wiss. Bd. 39 (1883), p. 295.

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before the spicules of the sponge were developed. Nassonow thought both chemical and mechanical agencies were employed, but he could not demonstrate the presence of an acid.

The action of sponges on calcareous organisms in the ocean is a widespread and important one in disintegrating the innumerable shells, corals, and nullipores on the floor of the sea, as well as the calcareous rocks at its margin; and whether this ceaseless destruction is caused by intrinsic or extrinsic agencies (*e.g.* by the aid of carbon-dioxide in sea-water), there can be no doubt as to the magnitude of the operations. It is, moreover, noteworthy that, so far as known, only calcareous media are affected by boring sponges.

Burrowing in hard substances seems to be rare in the Cœlenterates, though *Peachia*, *Edwardsia*, and *Cerianthus* bury themselves in sand, clay, and mud. Prof. Haswell* mentions a minute Actinia which occupies cavities in a *Cellepora* much deeper than the length of the polyp itself. In most cases the orifices are furnished with a low projecting rim, and frequently two unite internally. This may, however, be an instance of the growth of the Polyzoan round the Actinia, and not an instance of true perforation. Whether the case of the Anemones in holes of the rocks at Jamaica differs from the foregoing in so far as perforation is concerned remains for further investigation.

Turning to another and somewhat higher group of marine animals, *viz.* the Echinoderms, it is found that at least one species—the Purple Sea-urchin (*Echinus lividus*)—excavates considerable cavities, in which it lodges, in rocks—sometimes in rocks so hard as gneiss and granite. Authors assign to the teeth the main agency in the perforations, yet the cavities are somewhat smooth.

J. W. Fewkes,† after a careful examination of the perforations of *Strongylocentrotus drobachiensis* on the coast of Grand Manan, United States, considers that the excavations are due to the motions of the animals produced by waves and tide as well as to teeth and spines. He also thinks that they play some part in the formation of pot-holes. Prof. Cragin in the same volume,‡ however, points out that similar urchins wedge themselves in most firmly if they find force applied to them, so that the wave-action is doubtful.

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* Proc. Linn. Soc. New South Wales, vol. vii. p. 608, 1882.

† 'American Naturalist,' vol. xxiv. p. 1, 1890.

‡ *Ibid.*, p. 478.

The Annelids, again, include many forms which ceaselessly bore through sand (like the lobworm), earth (as in the case of earthworm), peat, and many soft media. Others penetrate aluminous shale, sandstone, limestone, shells, and various solid substances. Each form, moreover, fashions a characteristic tunnel in the rock, so that the particular borer may in most cases be determined, even after the dissolution and disappearance of the animal. They do not, however, bore in wood, and though pieces of telegraph-cable have frequently been forwarded with accompanying annelids as the depredators, in no instance has it been deemed prudent to connect them with the injury. Some authors have a different opinion, but the misapprehension has arisen simply from the presence of formidable calcareous jaws in annelids found lurking in holes which have been drilled by other forms. In short, it is a revival of the ancient notion which, assuming the shells of *Teredo* to be its teeth, credited it with the habit of eating its way into timber. In the same manner it has been supposed that *Polydora* and other boring annelids have found their way between the valves of Oysters, and subsequently have been enveloped by the shelly secretion of the mollusk.

Certain members of a group somewhat allied to the Annelids—*viz.* the Gephyreans—also bore in calcareous substances, such as shells and limestone rocks, as well as more generally in mud and sand. Such include the little *Sipunculus* of the British shores, and which at St. Andrews makes cavities in sandstone; *Bonellia* of the more southern waters; and *Thalassema*, which Dr. Farran* found in limestone near Dungarvan, in company with *Gastrochæna*. Other members of the group are partial to boring in sand and tough clay, or muddy clay.

Certain forms allied to the Polyzoa likewise perforate calcareous rocks. Thus *Phoronis*, a form which in its larval state has relationship with higher types, has been found in tunnels in chalk, and so far as could be made out it appeared to have formed them. It is interesting that *Phoronis* often occurs in great numbers in the tough mucous sheaths in which an Australian *Cerianthus* lives.*

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* Ann. Nat. Hist. 2nd ser. vol. vii. p. 156.

The burrowing powers of all the foregoing forms would seem to be well calculated to secure protection for themselves, but there can be little doubt that they also perform an important function in the disintegration of dead shells, and in corroding the surface of calcareous and other rocks. While they thus act beneficially in regard to dead shells, the same cannot be said with respect to their interference with the living; for as soon as the perforations of either annelid or sponge touch the internal surface, the Oyster or Limpet, for example, secretes layer upon layer of the nacreous substance in order to shut out what is evidently an irritating intruder, and thus the thickness of the shell is often greatly increased.

So far marine animals have been dealt with which bore into various earthy substances, but others perforate wood and allied materials, like the Crustacea, whilst the Mollusca also do so, and likewise bore in rocks varying in hardness from chalk to granite, as well as make holes in other shells.

Boring and burrowing are common features amongst the Crustacea. Thus, to take them in their order, certain Cirripedes, e.g. *Alcippe lampas*, *Cryptophialus*, and *Lithotrya*, perforate shells, the former attacking the columella or axis of the shell, while the boring sponge enters the exterior surface and rapidly spreads over the whorls, so that between them the shell soon crumbles to fragments and disappears. Its discoverer (Mr. Hancock) did not think *Alcippe* bored by its shelly plates, though the perforations might "result from a solvent, or from the application of minute cutting bodies on a highly contractile, soft, and pliant surface."† Darwin‡ thought the burrowing of *Lithotrya* was mechanical, the peduncle being studded with calcified heads and star-headed spines, which form a rasping surface, and are worn away, to be replaced next moult. "It [burrowing] is effected by each layer of shell in the basal attached disc overlapping in a straight line the last formed layer, by the membrane of the peduncle and the valves of the capitulum having excellent and often renewed rasping surfaces; and, lastly, by the end of the peduncle (that is, homologically, the front of the head) thus roughened extending beyond the surface of attachment, and possessing the power of slight movement." Many crustaceans perforate sand, clay, mud or sandy mud, while two at least (*Chelura terebrans* and *Limnoria lignorum*) are well-known destroyers of wood.

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* Prof. Haswell, Proc. Linn. Soc. N.S.W. vol. vii. p. 341.

† Ann. Nat. Hist. 2nd ser. (4), p. 313, plates 8 and 9, 1849.

‡ Monogr. Cirripedia, pp. 336–348, 1851.

The first of these (*Chelura terebrans*) is a form less familiar to Scottish zoologists—especially those on the eastern shores—than to our southern colleagues. It is abundant, however, on the southern and western coasts and in Ireland, its range likewise extending to many parts of Europe and the United States. A similar form (*Chelura pontica*) is also described by Czerniavsky as occurring along with *Teredo* in the Black Sea, while elsewhere it is generally associated with the other form, *Limnoria*. In xylophagous powers it is even more destructive than the latter, since its excavations in timber are considerably larger and more oblique, the wood being ploughed up rather than bored into, so that the surface thus undermined is rapidly washed away by the action of the sea. In one of the many beautiful memoirs written by the late Prof. Allman, formerly the distinguished occupant of the Chair of Natural History in the University of Edinburgh, a description is given of these crustaceans in the timber-piles of the jetty of the Harbour of Kingstown, near Dublin. It has been calculated that *Chelura* will destroy a piece of Memel timber thirteen inches square in less than ten years, working from the level of the mud almost to the height of neap-tides. It is believed that the mandibles of the animal enable it to perforate the moist timber, which it swallows. The mouth-organs consist of an upper and a lower lip, a pair of mandibles, and two pairs of maxillæ. Between the spines and the base of the mandibles is an oval elevated surface marked with transverse ridges, which are again crossed at right angles by delicate striæ. Prof. Allman considered that this eminence constitutes a very efficient grinding surface. The last pair of appendages at the tail of the animal are remarkable in size and length, and probably aid in effecting various movements within its chamber, as well as in leaping (after the manner of a Springtail) when placed on a flat surface. Its movements in the water are very active, and it swims chiefly on its back.

The second form, *Limnoria lignorum* (the Gribble, as it has been popularly called), is an Isopod,* and closely allied to the *Sphæromidæ*, which occur in crevices of rocks, especially on the southern (Channel Islands) and western shores (Outer Hebrides). Though this form (*Limnoria*) must have been familiar to marine observers from a very early period, it was fully described by Dr. Leach only in 1811, when Mr. Robert Stephenson, the celebrated engineer, found it burrowing most destructively at the Bell Rock in the large beams of Memel fir supporting the temporary beacon in which he and his assistants resided. The sides of these beams had been charred and coated with pitch, but the ends resting on the rock had been overlooked, and there *Limnoria* began its operations. Other logs of pine were reduced at the rate of about an inch a year, and the house-timbers were so much destroyed that many stood clear of the rock, supported only by the iron bolts and stanchions. Since its ravages at the Bell Rock brought it under the notice of men of science it has been found very generally distributed on our shores from Shetland to the Channel Islands, and it is common in European waters. It attacks all kinds of submerged wood, such as piles facing the wharves, sunken wrecks, stakes of Salmon-nets, and indeed all unprotected wood. The late Dr. Coldstream, of Leith, the author of an excellent account of the animal, mentions that, in 1825, so extensive were the ravages of *Limnoria* that many of the piles of Trinity Chain Pier had to be replaced after four years' service, and studded all over with broad-headed iron nails from the base to the limit of high-water mark. The same plan was adopted in extending the pier at Leith on wooden piles four years afterwards (at a cost of £1000, the whole pier being £30,000). At Devonport Dockyard at this moment it is more troublesome than the *Teredo*.

Like the foregoing species, *Limnoria* uses its mandibles for burrowing, and the particles of wood are swallowed. It generally chooses the softer places, shunning the knots and hard lines of wood. It even avoids the New Zealand pine (Cowdie). As already mentioned, it is effectually kept out by studding the surface of the piles with large-headed iron nails (scupper-nails), the oxidation of which in the sea-water rapidly impregnates the surface to a degree distasteful to the creatures. In the case of wrecks it is, however, observable that their borings closely approach iron bolts, so that ferruginous wood is not always shunned. At Devonport Dockyard the most approved method of warding off the attacks of *Limnoria* is to use good Memel timber (fir) thoroughly impregnated with creosote, this absorbent wood taking in about ten pounds to the square foot. The wood is well dried and warmed before being treated.

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* An elaborate and well-illustrated Report on this form was published by the Netherlands Commission in 1893.

This habit of penetrating wood is unquestionably a very ancient one with *Limnoria*, but within comparatively recent years another taste has developed itself, *viz.* that of perforating the protecting envelopes and gutta-percha in which submarine telegraph-cables are sheathed. This habit is no less disastrous than the former, for by exposing the wires their insulation is interfered with, and the cable has to be raised for repairs. Considerable doubt seems to exist in regard to the form which is thus so troublesome to telegraphic engineers; indeed, it is a prevalent impression that annelids cause the mischief. Thus, amongst others, the late Dr. Carpenter forwarded *Nereis pelagica*, a common annelid, which like *Nereilepas* has the habit of dwelling in holes made by various borers, as the depredator in the case of a Spanish cable. Dr. Gwyn Jeffreys and Sir John Murray sent examples of others, including the French Atlantic cable from a depth of thirteen hundred fathoms. In all these *Limnoria* or *Xylophaga* appeared to be the cause of the faults, the repair of which is often a costly undertaking. Thus Mr. Andrews,* who found *Limnoria* in the gutta-percha coating of the submarine cable between Holyhead and Ireland, observes that a loss to the company of no less than £10,000 was eventually caused by this diminutive yet destructive crustacean. It would appear, therefore, that the views of Dr. Wallich,† who thought that "if any material exists, the characters of which are so thoroughly dissimilar from those of any substance known to occur at the bottom of the sea as to render it highly improbable that such creatures as live there could improvise means to pierce it, whilst at the same time it would secure perfect insulation of the telegraph-wire, *caoutchouc is that material*," have not been verified.

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* Quart. Journ. Micros. Sc. (ii.), 15, p. 332.

† Ann. Nat. Hist. 3rd ser. (8), p. 58, 1861.

The work of the burrowing crustaceans, however, is quite overshadowed by the far more serious encroachments which the boring shell-fishes are capable of making in timber and similar substances, as well as in rocks of diverse kinds.

Many are probably familiar with the perforations of the various species of *Pholas* on rocky shores, for they bore in sandstone, gneiss, mica-schist, limestone, chalk, lava, aluminous shale, peat, wood, and even wax. All round the western and Castle rocks at St. Andrews, as well as at many parts of the eastern rocks, the shale, limestone, and sandstone are extensively perforated by *Pholas crispata*, and less frequently by *P. candida*, while the calcareous rocks and chalk of the southern shores of England abound with another species, viz. *P. dactylus*. All these are occasionally used as food, like their southern congener of the coasts of Italy, *viz.* the date-shell (*Lithodomus*). *Pholas candida* seems to bore at St. Andrews in rocks somewhat beyond low water, for it was only when the blasting operations of 1896 connected with the drainage works took place that fine examples of this species were thrown in numbers on the beach, and collected by Dr. Mactier.* *Gastrochæna*, again, mostly frequents the shells of other mollusks such as *Pecten* on the southern coasts, and lines its tube with a shelly secretion. It likewise bores in granite and limestone, yet its external horny layer presents slight evidences of friction—indeed, only at one end.

The effect of the ceaseless boring of rocks all round the shores of Britain by *Pholades*, *Saxicara*, and other forms must be noteworthy, since at and beyond low water the sea, especially in storms, will break up the much perforated ledges of rock, liberating the adult as well as the smaller *Pholades* as food for other marine animals, but not before an abundant series of larvæ carry the operations to fresh sites, which range from half-tide mark to the laminarian region, and probably beyond. No effort of man can modify to any extent these natural conditions, especially in connection with their inroads. On the other hand, the deposits going on in the bed of the sea, the drifting of ordinary and coral sand, and the increase of the deltas of rivers are examples of agencies which tend to counterbalance the effects of such erosion.

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* This rare mechanical cause is analogous to the action of certain remarkable storms which once in fifty years may send such species as *Thracia convexa* on the beach at St. Andrews, where it was also collected by Dr. Mactier.

A closely allied species, *Xylophaga dorsalis*, which occurs abundantly in the deep water off the Forth (*e. g.* east of the Island of May, and off St. Abb's Head), as well as elsewhere both in England and Scotland, confines its boring action entirely to wood. This little bivalve mollusk has two helmet-shaped convex valves crossed by very fine striæ. Two small dorsal shields or plates are likewise present. It shows certain intermediate characters between the stone-borers just mentioned (*Pholades*) and the typical wood-borers (*Teredines*), having the short siphons of the former, the habit of perforating wood only to the extent necessary for its safety, and in having no calcareous lining to its tunnel; while in the structure of its valves it mainly leans towards *Teredo*. The late Dr. Gwyn Jeffreys, the able and experienced author of 'British Mollusca,' is doubtful whether the soft parts of the animal can be contained in the shell, but in all the living examples both from the eastern shores and those from the Outer Hebrides, such can readily be retracted within the outline of the valves.

In wood attacked by *Xylophaga* there is very little externally to attract attention, except the presence on the surface of minute apertures, which probably indicate the points by which the young animals obtained entrance. On breaking the wood the adults are found in smooth tunnels in every fragment large enough to afford a lodgment. Thus even a willow-basket will be invaded by them, especially the ribs, which are somewhat thicker than the other parts. The burrows are quite smooth, and generally contain greyish pulpy *débris* of minute grains of wood, which have passed through the alimentary canal and been ejected by the excurrent siphon. Most of the perforations are against the grain of the wood.

The effects of *Xylophaga* in connection with the destruction of wood in British waters are considerable, especially in the case of submerged branches, but they fall far short, both in British and foreign seas, of those of the widely distributed genus *Teredo*. As a rule, every piece of wood from the wrecks of ships and boats on the eastern coast, and which has lain for some time on the bottom, is riddled by *Teredo*, and occasionally by *Xylophaga*. Their development seems to be such as to spread them rapidly and widely over large areas. The minute larval forms (in *Teredo*) are found in the branchial cavities in June, and in the middle of July the young, though very small, are fully formed. In September they penetrate the wood. It is further stated that these minute forms often fix themselves to a piece of wood so thin that development can only take place up to a certain size, when all must perish. This is thought by some to be a provision for keeping their increase in check, but such is probably inappreciable.

In regard to the hard parts, the globular valves agree with those in *Xylophaga*, being helmet-shaped and sculptured in a remarkable manner, so as to present a file-like surface, the function of which, not a few observers consider, is to aid in perforating the wood. There are no shelly plates or shields such as occur in *Xylophaga*, but attached to the muscular ring at the base of the siphons are a pair of pallets, which are useful to zoologists in discriminating the species, and to the animal for protection. Thus when alarmed it withdraws its long siphons within the shelly tube, and guards the aperture by folding the calcareous pallets over the tip, just as the annelid, *Lagis koreni*, does with its broad golden bristles. *Teredo* more readily accomplishes this by the presence of ledges projecting from the narrow or outer end of the shelly tube, which is a secretion of the mantle.

The food of the *Teredo* consists of Diatoms, Infusoria, and other minute pelagic plants and animals which abound in all climes in the sea. It is only necessary to drag a tow-net a little distance below the surface of any of our bays (either in summer or winter) to find an abundance of minute forms—amply sufficient to nourish these and other marine animals. The shipworm thus has no need to depend for subsistence on the minute particles of wood which it swallows, though, like the Swedish peasants with their Bergmehl, or the eaters of clay in North America, such doubtless increases the bulk of the food.

In the tube of the *Teredo*, and also in the tubes of *Pholas*, as the learned Jesuit, Bonanni, discovered so far back as 1684, an annelid (*Nereilepas fucata*) often occurs, and some observers mention that it performs the part of keeping the mollusks in check—in short, that it is a destroyer of *Teredo*. So far as known there is no foundation for this view. It is found that the same species of annelid frequents, along with the common Hermit-Crab, the shells of the Great Whelk, not for any predatory reason but simply as a commensal. The association of annelids with other forms in tubes or elsewhere is extremely common; indeed, many are found only in this association, but it is not for the purpose of preying on their neighbours, though the bodies of their hosts in many cases are softer than those of *Teredo*, and their own jaws not less formidable than those of *Nereilepas*. They are commensalistic forms or messmates—that is, dwell in association with other animals, each, as the late Prof. Van Beneden, of Louvain, tersely said, requiring from his neighbour a simple place on board his vessel without asking to partake of his provisions. Besides, Nereids have a habit of lurking in holes of any kind, and even perforating peat for shelter; and it would be unsafe to condemn them from an examination of their jaws, since some of those best armed live only on seaweeds.

But—to return from this digression—it is found that no fewer than four British species of *Teredo* and several others are occasionally found in driftwood. In the great and especially the warmer oceans almost every piece of timber is attacked, so that strict precautions are necessary to protect wooden ships, boats, and piles from their ravages.

The object in life of all the species of *Teredo* is to bore ceaselessly into timber, which they tunnel for the protection of their long worm-like bodies, and they line the interior of their tubes with a calcareous coat, which helps in some cases to separate them from their neighbours. The perforations are generally in the line of the grain of the wood, and vary in length according to the size of the specimen and the particular species. Thus the common *Teredo* (*T. navalis*) has a tunnel from one to two feet in length, while that of the giant Shipworm (*T. arenaria*) extends fully a yard, and is two inches in diameter. A curious species (*T. corniformis*), which burrows in the husks of floating cocoa-nuts and other woody fruits in tropical seas, has extremely contorted tubes, from the limited area at its disposal.

In connection with distribution it was formerly supposed that *Teredo* did not bore under twenty fathoms, but it is quite a common thing to dredge pieces of water-logged wood from much greater depths with the living mollusks in the perforations, as in the deeps off St. Abb's Head and beyond the Island of May. Certain foreign species, again, live both in fresh water and in brackish, one, for instance, burrowing in the roots of the mangrove trees in the rivers on the West Coast of Africa, into which the sea-water penetrates only at intervals.

As might have been expected from their marked effects on submerged wood, these boring mollusks were well known to the ancients. As Forbes and Hanley and others state, they (*Teredines*) are mentioned for the first time in the "Knights" of Aristophanes. Theophrastus, the favourite pupil of Aristotle, also probably alludes to *Teredo* when he speaks of "worms which corrupt wood in the sea." Pliny the elder designates the same form as the large-headed *Teredo* "which gnaws with teeth and lives only in the sea"; and similar easily recognisable allusions are made by Ovid and other authors. The ravages made by *Teredo* on the piles composing the dykes for resisting the inroads of the sea in Holland, however, prominently brought it before the natives of that country, and three investigators took it in hand between 1720 and 1733, *viz.* Massuet, Rousset, and Sellius. On the present occasion it is unnecessary to enter into an account of the labours of each of these, but an excellent *résumé* is given in the 'British Mollusca' by the accomplished authors, Prof. Edward Forbes and Sylvanus Hanley. One paragraph only need be quoted. It is :—"Massuet was a Belgian, and had been a Benedictine monk, but became a Protestant and took refuge in Holland, where he studied medicine under Boerhaave. He was fortunate; for, dividing his time between his patients and his researches, he saved enough to buy a seigneurie and die rich. He wrote on history and natural philosophy. Rousset began life as a soldier, and quitted the sword for the birch. He would not have meddled with the *Teredo*, but that it took part itself in the political prospects of Europe. Sellius was a native of Dantzic, very learned but very unfortunate. He wrote a work of three hundred and sixty pages on *Teredo*, citing within it nearly two hundred authors, and bringing all the learning of the ancients and the moderns to bear on the subject." This Dutch naturalist correctly recorded that the animal was a shell-fish, a fact which Linnæus overlooked, since he placed *Teredo* in his heterogeneous group "Vermes"—a division comprising many widely divergent forms. An interesting account of the subsequent literature of the subject is given by Forbes and Hanley, and more recently by Gwyn Jeffreys, in their respective works.

In boring the timber it is a fact of interest that the animals avoid the tubes of each other, though perhaps it may not be considered, as Sellius did, that they are actuated by a conscientious anxiety to avoid injury to their fellows. Sellius, indeed, was of opinion that *Teredo* closed in its shelly tube and died of starvation rather than penetrate into the tunnel of its neighbour.

Stokoe* more recently made the observation that in certain fossils, consisting of the harder parts of the skeleton and teeth, the boring mollusks did not affect the enamel or enamel-like dentinal layer, a fact which shows that they discriminate between such and the parts more easily penetrated. In respect of avoiding the tunnels of its neighbours, *Teredo* offers a contrast to *Limnoria*, for in the stakes of the nets for Salmon on the West Sands, at St. Andrews, the tunnels of the latter sometimes meet, and thus the young, ten or twelve of which occasionally accompany the parents at the end of the burrow, may more readily spread throughout the wood.

The destruction caused by the animals in the harbours of our own country is considerable, since it has been computed that at Plymouth and Devonport alone many thousands of pounds' worth of wood are annually destroyed. The French and Dutch, however, suffer much more seriously, the former in regard to harbours, the latter in regard to piles. Special commissions in both countries have, indeed, been appointed to investigate the subject, and various reports have been issued, to some of which allusion will by-and-by be made.

The opinion of the older authors that the valves of the *Teredo* were the teeth by means of which it gratified its appetite

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* 'Nature,' vol. xx. p. 428, 1879.

—by devouring all the wood it eroded—could not long satisfy more philosophic inquirers, and accordingly many able memoirs on the boring of these and other marine animals have enriched zoological literature during the last century. In briefly alluding to these the perforations in various hard substances will be included, in order to illustrate the several features of the action.

It will be found that the theories which have been brought forward to explain the mode by which marine animals perforate materials so different as wood, limestone, resin, wax, granite, sandstone, and aluminous shale, range themselves round two great centres—the *chemical* and the *mechanical*, for it is unnecessary to dwell on such as those of a few, who fancied that *Pholas*, for instance, only bored in soft clay, and that its presence in stone was due to the petrifaction of the soft materials around it. This explanation is comparable to that of the religious authority mentioned by Hugh Miller, who accounted for the beautiful fossil fishes in the rocks by courageously asserting that "they were formed of stone from the very first."

The advocates for the *chemical* theory seem to take it for granted that the borings occur chiefly in calcareous substances, and with propriety, therefore, they make their solvent an acid. It is clear, however, that this notion is unable to explain the perforations in media totally impervious to such action. Moreover, no trace of acid is found in many borers, and though present in some it is likewise characteristic of other marine animals which do not bore. Further, it is purely hypothetical at present to bring in the aid of carbon-dioxide derived from sea-water for the same reason.

The *mechanical* theory, again, supposes that the animals perforate by means of shells, gritty particles, or odontophores in the case of mollusks, teeth in the sea-urchins, bristles in the annelids, horny processes in certain sea-acorns (Cirripedes) and Gephyreans; but doubt remains concerning the extensive and wonderful excavations of the sponges, those of the Bryozoa, the *Helices*, and the rest of the Cirripedes. If, however, the theory of "maceration" is regarded as a modification of the foregoing, certain objections will disappear. The grains of wood found in the stomach of *Xylophaga* and *Teredo* are, however, interesting in this connection.

In regard to the borings of mollusks, many authors—such as Bonanni, Adanson, Born, J. E. Gray, Fleming, Osler, Forbes and Hanley, Cailliaud and Robertson—have believed that such are made by rotations of the valves after the manner of augers. Little, however, is said about the smooth valves of such as *Saxicava*, *Gastrochæna*, and *Lithodomus* in contrast with the rough valves of *Pholas* and *Teredo*.

This theory, however, is not supported by an examination of the perforations of the Algæ, Sponges, Bryozoa, those of the Annelids, Gephyreans, Cirripedes, and *Helix*, nor by a comparison of the shells and tunnels of the animals themselves. The texture of the valves of the date-shells, for instance, is so soft that they could not act materially on the hard stones into which they bore. Moreover, it has to be remembered that the surface of such shells is covered by the periostracum, which would materially suffer before much effect could be produced on the rocks.

Hancock, again, propounded the theory that the holes were made by silicious particles in the foot of the mollusk (which particles could not, however, be found by that most accurate and conscientious observer, the late Prof. Busk), while Bryson gave the chief action to grains of sand from the exterior. Fisher thought that they were effected by the foot in some way. None of these views would explain the perforations in limestone by the "Hélices saxicaves" of Bouchard-Chantereaux.* Other authors asserted that the annelids bored by aid of their bristles, just as Darwin had predicated of the Gephyreans and their chitin.

A more gentle method of tunnelling was that advocated by Garner, who held that the excavations were due to ciliary currents aided by rasping. The currents may assist, but seem to be insufficient to account for the borings in any group.

The next theory is one that has been frequently applied to the action of marine animals on their surroundings, *viz.* that the perforations are due to a chemical solvent. Amongst others who have chosen this explanation may be mentioned Gray, Osler (for *Saxicava*), Drummond, Cailliaud, Mantell, Thorrent,

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* Ann. des Sc. Nat. 4e sér. xvi. pp. 197–218, pl. 4. These figures exactly correspond with a fine mass of limestone perforated by *Helix* sent by Dr. Scharff from Ireland.

Reeve, Bouchard-Chantereaux, Spence Bate, Darwin (for *Verruca*), Ray Lankester, Parfitt and Schiemenz (for *Natica*). The latter has shown that the main agent in the small holes made in mussels and other shells by *Natica josephina* at Naples is the boring-sucker on the under surface of the proboscis.* Carazzi also describes the perforations of the date-shell (*Lithodomus dactylus*) as being due to chemical action, since its perforations are keyhole-shaped. It differs thus, he says, from *Pholas*.

But this view will not explain the extensive perforations in wood (now specially before us), in aluminous shale, gneiss, granite, sandstone, gutta-percha, resin, and wax. It is interesting, however, that shells and calcareous rocks are much affected by burrowing marine animals. Moreover, it is well known that even gentle friction on a wet calcareous surface—as by the feet and tails of Wallabys and allied forms at a drinking-place—will make a beautifully polished "face" like that on the finest marble.

Thompson and Necker, again, were of opinion that the boring action was a compound one—the result of a secreted solvent, aided by rasping; hence the solvent would require to vary with the nature of the rock attacked.

Lastly, the very old idea of Sellius (and Deshayes), adopted by Gwyn Jeffreys, has to be considered, *viz.* that the perforations are caused by a macerating or simple solvent action of the foot, and De Quatrefages thinks also of the mantle.† This would certainly avoid many of the difficulties caused by the previous theories, but it is doubtful if much support for this opinion would be derived from the action in Sponges, Bryozoa, Annelids, Gephyreans, and Cirripedes. It has also to be borne in mind that the crustaceans which burrow in wood do so only by mechanical means, and so with certain burrowing insects.

Leaving the subject of the means, which would appear to be varied, by which marine animals bore for the present, a glance may now be taken at the methods of protecting timber from their ravages. Very many suggestions and experiments have been made with this view. Even so early as the days of Sellius several hundred preparations were known, most of which, however, were useless. At the present time the means for defending submerged timber from a scourge so serious group themselves under two heads, *viz.* (1) in regard to the kind of wood employed, and (2) the treatment of the wood before immersion.

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* Mitt. Zool. Stat. Neapel, Bd. x. p. 152, Taf. 11.

† This recalls the statement that if a plant be permitted to grow on polished marble an outline of the root is marked on it, a result supposed to be due to an acid secretion (chlorhydric) of the root-hairs. Prof. J. H. Storer, indeed, endows the rootlets with what he terms a power of osmotic dissociation, and he would extend the same explanation to the boring animals (Amer. Jour. Sc. 28, pp. 58–61, 1884).

In the first category, it is stated that *Teredo* will not touch the Pyengadu or Ironwood Tree, a species of *Acacia* from the Burmese forests. It contains a thick gelatinous oily substance. The same is said of Huon or Macquarie Harbour Pine, Tasmania, and the Kaurie or Cowdie Pine (*Dammara australis*) from New Zealand. The Jarrah Tree (*Eucalyptus marginatus*) defies *Teredo* and the white ants, so that copper-sheathing is unnecessary, a state probably due to its odour or taste, as no specially distasteful chemical substance, acid or otherwise, has been found. The Heartwood Tree (*Nectandra Rhodiœi*) of Guiana, which furnishes *Beberia*, is considered by some to be proof against *Teredo*, though this is doubtful. It pertains to the natural order *Lauraceæ*, which comprehends sweet-bay, camphor, sassafras, and other well-known forms. Other woods, such as sneezewood from the Cape; teak, hemlock-tree with its bark, Cay-don from Cochin China; and various hard and close-grained woods have been recommended, though, so far as known, with comparatively little success on a large scale.

Under the second head fall all the chemical and other substances which have been applied to the exterior of the wood, or forced into its tissue under great pressure. Many preparations of tar and varnish would suffice to keep out the young *Teredo*, if such would remain intact, but unfortunately friction soon interferes with their continuity, and then a lodgment is effected. Soluble bitumen (composed in all probability of pitch and wax), silicate of lime, and various patent compositions have each in turn been tried externally; while the silicate of lime, creosote, and other fluids have been driven under great pressure into the tissue of the wood.

The Dutch Commissioners experimented with metallic substances—Russian talc, paraffin varnish, oil of tar, various kinds of paint, and by carbonising (by burning) the surface of the wood; but none of these methods met with their confidence.

Impregnation of the wood was next tried with sulphate of copper, sulphate of iron, acetate of lead, calcium chloride, oil of tar, and creosote. The latter alone, and only when thoroughly carried out, was found to be useful; and at the present moment this, sheathing in copper, and the studding of the timber with broad-headed nails (scupper-nails) are the only reliable methods adopted in the Netherlands. And yet creosoted timber is not always safe, for Dr. Gwyn Jeffreys found it attacked in Sweden. Somewhat recently an American has recommended that a cylindrical excavation round the core of logs of wood should be filled with a special cement, impenetrable to *Teredo*. It would be difficult, however, to adopt this on a large scale.

While the Dutch, French, and other Commissions have thus done material service in regard to the best means for protecting timber from the attacks of various borers, the subject is by no means exhausted. On the contrary, it would form a fitting one for modern research at the Marine Laboratories.

In the foregoing remarks only a brief *résumé* has been given of the kinds of marine animals which by the extent of their perforations materially affect submerged timber and other solid substances. In conclusion, however, it is well to draw attention especially to the fact that this ceaseless boring in wood is not an unmitigated evil, even though Mr. Brunel had not received a hint from *Teredo* in forming the Thames Tunnel. The masses of timber swept seawards by many foreign rivers would prove a serious impediment to navigation if the marine borers did not slowly but surely accomplish their dissolution. In the same way floating timber and the relics of many a ship and boat in the depths of the sea are disposed of. Fortunately the extensive use of iron and steel in shipbuilding now renders the ravages of the borers in wood less prominent. Moreover, vast numbers of shells are broken down by boring sponges, annelids, boring algæ,* and other forms, and ultimately are either altogether dissolved or deposited as shell-gravel. Further, this increase of animal life—both larval and pelagic, and adult and sedentary—is every-

* Bull. Amer. Mus. Nat. Hist. xxv. pp. 323–332, 1902.

where utilized directly or indirectly for the food of fishes at various stages of growth, the minute young capturing the larvæ, and the older forms feeding, for instance, on the boring shellfishes scattered by the breaking up of the honeycombed slabs on the floor of the ocean. Thus the ultimate result of all these processes would not appear to be wholly disadvantageous to man.

In connection with the perforations of marine animals in hard materials, it is to be hoped that fresh and careful observations will by-and-by be undertaken in every group available on our shores, not primarily for the sake of avoiding the comparatively slight erosions thus caused on the coastal rocks, or of interfering, even were that possible, with the beneficial action on submerged driftwood and wrecks, but for the purpose of increasing knowledge. Quite recently the country has embarked on an outlay which will not fall far short of £100,000 for marine investigations which, if for the moment the pleasant international *camaraderie* is put aside, experience knew from the inception were on the main point futile, or, at best, could only substantiate what already had been proved. It might be well if the Government considered, in this light, whether in the past it has done its duty to scientific marine investigations at Marine Laboratories.

NOTES ON THE ARCTIC WHALING VOYAGE OF 1907.

By Thomas Southwell, F.Z.S.

Bad as the voyage of 1906 proved to be, when only seven Whales were killed, that of 1907 was far more disastrous, the chief causes of which were severe weather and unfavourable ice conditions. I am informed that in Davis Strait on many occasions Whales were seen, sometimes quite near the vessels, but it was impossible to lower the boats for their capture. The result is that in all only three Whales were captured, one of which, little better than a sucker, was procured in Davis Strait, the other two at the Greenland fishery.

It is curious that during the past two seasons the greatest success (small, indeed) has been obtained in the Greenland Seas, where these Whales were believed to be practically extinct, so much so that no vessels were despatched there for several years, whereas in the Davis Straits only three Whales have been killed in the past two seasons against six in Greenland; but in both regions more Whales were seen than captured, particularly in Davis Strait, where they are reported, especially late in the season, to have been very restless, and always on the move, a fact which the captains found it difficult to understand; so far as could be seen no Grampuses, their greatest enemies next to man, were about to produce the disturbance. The weather is said to have been atrocious in the Straits during the whole season, and other conditions, the worst ever remembered.

Seven vessels left Dundee, as last year—the 'Active' for Hudson Strait, whence she returned with a rather miscellaneous cargo collected at the winter station there, consisting of 32 White Whales, 374 Walruses, 185 Seals, 65 Bears, 650 Fox-skins, and 22 tuns of oil, but no Whales.

The 'Scotia' first visited Greenland, where she captured two Whales of eleven feet and nine feet bone respectively, yielding 32 cwt. of bone; a third Whale broke away with nineteen lines and was lost. Others were seen but not captured. The season was very unfavourable for the northern fishery, but the southern—apart from fogs—was very fair. From Greenland the 'Scotia' proceeded to Davis Strait, but there had no success.

The other five vessels—the 'Diana,' 'Balæna,' 'Eclipse,' 'Morning Star,' and 'Windward' went to Davis Strait direct, where the only Whale captured was the sucker already mentioned, killed by the 'Diana,' which yielded only half a hundredweight of bone—a poor return for seven months' toil. The other vessels were still more unfortunate. When opportunities did occur their attempts were always attended with disappointment—fog coming down or harpoons drawing. Indeed, the voyage is described as one continuous battle against storm, ice, and fog.

We have yet to speak of the 'Windward.' On June 25th this vessel struck upon a submerged rock near the Carey Islands, and became a total wreck. Her crew took to the boats, and after terrible exposure and great hardships they were eventually rescued by the 'Morning Star' on July 6th. Death also added to the misfortunes of the fleet. On June 14th the engineer of the 'Windward' died, and on August 16th one of her rescued crew died on board the 'Eclipse,' which latter vessel also lost one of her hands by death.

The ships' logs, from the beginning of the voyage to its end, are said to be a continuous record of battling with wind, sea, and ice, varied with spells of what sailors dread more than these—Arctic fog; added to which the want of success which attended their efforts to capture Whales when seen, the deaths of their companions, and loss of one of the fleet render the voyage of 1907 one of the most disheartening on record.

In addition to the seven vessels named the ketches 'Snowdrop' and 'Albert' brought home produce collected at the Frobisher Strait and Pond's Bay stations, the latter reporting that they had only seen one Whale during the whole season.

The total result of the season's fishing, including the produce brought home by the 'Snowdrop' and 'Albert,' was three

Whales, 36 White Whales, 634 Walruses, 1021 Seals, 258 Bears, 740 Fox-skins, 97 tuns of oil, and 32½ cwt. of bone. A large proportion of this miscellaneous collection was obtained at the winter stations. The price of whalebone, the quantity of which in hand from the North Atlantic is, I believe, very small, is about £2400 per ton, and that of oil £22 10s. per tun. The total value of the whole produce is roughly estimated only at about £13,000.

What will be the result of the series of disastrous years, entailing so serious a loss upon the "adventurers," it is difficult to say. Perhaps there is no industry which offers such prizes to the successful, but the climatic conditions on which to so large an extent success depends are so uncertain that the enterprising Dundee merchants may still be tempted to court fortune in the frozen North.

I am, as usual, much indebted to Mr. Robert Kinnes, of Dundee, and for statistics to Mr. Mitchell's 'Circular.'

BIRDS OF THE GRAAKALLEN MOUNTAIN, NORWAY.

By Rev. William Serle, M.B.O.U.

The Graakallen—a mountain rising nearly 2000 feet in height—is a well-known ski-ing resort, six miles south of the town of Trondhjem, North Norway. On the top it is bare and rocky, but the slopes are covered sparsely with pines, while some little lochs lie around the base. On its slopes I lived from May 18th till June 6th, 1907, and I spent the time wholly studying its bird life. Unfortunately for my purpose the season was an abnormally late one, and whilst at the beginning of my stay birds were scarce, when I left they were becoming abundant in every spot—I only saw one Willow-Warbler at Trondhjem on May 11th; by the beginning of June they simply swarmed on the Graakallen. I seemed to think the migrant birds that gradually ascended the hill-slope did not first strike Norway by the Trondhjem Fiord, but by the mouth of the Orkla River, thence into the valley of the River Nid, and so reached the Graakallen; and I might further remark, judging from the type of coast-land between Bergen and Trondhjem, that migrants from the Scottish coasts will likely seek the Norwegian coast to the north of Trondhjem, leaving the greater part of Norway to be occupied by birds migrating north by way of Heligoland and the entrance to the Baltic. Birds were comparatively tame, and were not molested by boys. I noted a kind of nervousness about them, but then they are seldom disturbed in their breeding haunts. I give a list of the birds observed on the Graakallen, omitting the Gulls, which flew across country from the harbour at Trondhjem to the mouth of the Orkla.

Mistle-Thrush (*Turdus viscivorus*).—I came upon a pair on the east slope of the hill, pretty low down, which seemed to have a nest, judging from their anxious behaviour.

Song-Thrush (*T. musicus*).—Distributed all over. Strange however, were it not for their song it was easier finding their nests than getting a sight of the birds. Here they are very quiet and retiring in their habits and seldom seen; they began singing about 10 p.m., and sang more or less all night, but their song had not the compass or quality of home birds.

Redwing (*T. iliacus*).—This bird, not over-abundant when I arrived, became very common later. I saw them first on May 17th, crouching on the sides of the road whilst showers of snow were drifting past. It is rather difficult wading among the deep snows amid the pines, yet I found a good few nests, and could easily have found more had I been anxious. Their trilling song is very pleasing and very characteristic of these lonely parts, and gives a good indication of the number of pairs that may be breeding around. Their nests were fairly well hidden, built low down, and one I found built against a boulder. I took the first full clutch on May 22nd, and I saw young ones well grown on June 3rd; yet in the valley leading down to Loch Shelbrea I found no nests on June 5th, although the Redwings were numerous, and by their behaviour they indicated they were later in breeding in that valley.

Fieldfare (*T. pilaris*).—A most abundant bird, breeding in colonies; later I noted birds nesting separately further up the hillside. I took a clutch on May 18th. Here the colony at the time was small, but it became a large one before I left. Fieldfares are very noisy at their nests, and do their very best to tell you where they are. They build higher on the tree than Redwings.

Ring-Ouzel (*T. torquatus*).—There were scattered pairs all round. They had not commenced breeding when I left, but then a lot of snow fell during the last five days of May, and the Ring-Ouzels frequented exposed parts.

Wheatear (*Saxicola œnanthe*).—A common bird. It had commenced to breed before I left.

Whinchat (*Fratincola rubetra*).—A common bird in suitable spots. A persistent singer. These birds had not started nesting at the beginning of June.

Redstart (*Ruticilla phœnicurus*).—Common. They commenced breeding in June.

Golden-crested Wren (*Regulus cristatus*).—It was easier to hear their squeaking notes in the pine-woods than to see the birds. They were not common.

Willow-Warbler (*Phylloscopus trochilus*).—By the first days of June they simply swarmed everywhere, but had not commenced breeding. I seemed to think their notes louder than at home.

Hedge-Sparrow (*Accentor modularis*).—A lonely retiring bird here, but common; its numbers increased as time went on. A heavy snowstorm late in May covered a nest containing five eggs. I thought the bird would have deserted the nest, yet in a day or two she returned and began to incubate.

Great Tit (*Parus major*).—Though common low down, I only heard their notes on the hillside when June had come.

Northern Marsh Tit (*P. palustris borealis*).—Common everywhere. It was a pleasure listening to their notes. They are very light in colour.

Wren (*Troglodytes parvulus*).—I saw it, but it is evidently scarce.

White Wagtail (*Motacilla alba*).—Common when I arrived, scarcer later when they scattered to breed.

Tree-Pipit (*Anthus trivialis*).—One took up its quarters in a bit of marsh near a stable.

Meadow-Pipit (*A. pratensis*).—A few pairs were to be found about the mountain.

Siskin (*Chrysomitris spinus*).—This pretty bird was in fair numbers. I noted one carrying nesting material.

Greenfinch (*Ligurinus chloris*).—I noted but one, feeding on a juniper bush.

House-Sparrow (*Passer domesticus*).—The first Sparrow—a female—appeared where I stayed on May 30th. They bred later.

Chaffinch (*Fringilla cœlebs*).—Everywhere common.

Brambling (*F. montifringilla*).—A common bird. They were only commencing to build when I was leaving.

Linnet (*Linota cannabina*).—I noted a few.

Northern Bullfinch (*Pyrrhula europæa major*).—Two pairs of this large form of Bullfinch were always to be found at two certain spots.

Yellowhammer (*Emberiza citrinella*) —Fairly common, and not objecting to the pine-woods.

Starling (*Sturnus vulgaris*).—The first one appeared where I was staying on June 3rd. The proprietor was delighted to have them back for the season. He told me that a pair had remained for the first time during the last winter at a neighbouring farm place in the Nid River valley.

Magpie (*Pica rustica*).—A common breeding bird.

Hooded Crow (*Corvus cornix*).—Common; and suspiciously watched when he looks near a Fieldfare colony.

Cuckoo (*Cuculus canorus*).—First heard on June 1st from the top of the Graakallen. Two were calling to one another from a high snow-covered moor to the south—odd-looking surroundings, I thought, for the bird.

Buzzard (*Buteo vulgaris*).—A large Hawk, I am pretty sure, of this species I saw flying across Loch Shelbrea carrying something to a thick clump of pine on the side of the mountain.

Mallard (*Anas boscas*).—A pair frequented a little sheet of water.

Ptarmigan (*Lagopus mutus*).—An abundant bird all over the mountain.

Capercaillie (*Tetrao urogallus*).—I saw a few of these birds among the pines. People spoke of these and of Black Grouse as common.

Woodcock (*Scolopax rusticola*).—A few seen regularly at nightfall flying down to a marshy tract of land to feed.

Sandpiper (*Totanus hypoleucus*).—A common bird on the small rivulets flowing down to the lakes.

Curlew (*Numenius arquata*).—A few scattered all round.

ON THE EVOLUTION OF *DINARDA*, A GENUS OF COLEOPTERA.

By Erich Wasmann, S.J.*

(Translated by Horace Donisthorpe.)

As an instance of recent species building, ... I brought forward, in 1901,† the genus *Dinarda*, in the Brachyelytra (*Staphylinidæ*). It can be shown that our North and Central European two-coloured (red and black) forms of *Dinarda*, which are adapted to different species or races of the genus *Formica*, stand in different stages of species building. Two of these—*Dinarda dentata* (with *F. sanguinea*) and *D. märkeli* (with *F. rufa*)—have already become throughout their area of distribution such constant forms that they have been hitherto not incorrectly treated as species. Two other nearly related forms, on the other hand—*D. hagensi* (with *F. exsecta*) and *D. pygmæa* (with *F. rufibarbis*, and especially with the var. *fusco-rufibarbis*)—are still considered to be in the process of adaptation to their ant-hosts; in some parts of the area of distribution of the latter they have already become well-defined forms; in other regions they still show numerous transitions towards *D. dentata*; finally, in others, no adaptation of *Dinarda* to *F. exsecta* and *rufibarbis* has yet taken place. We have also before us in these two forms of *Dinarda*, which gradually approach in the path of variety and race-building, every stage of species building which has already been reached by *Dinarda dentata* and *märkeli*. My previous observations have strengthened these ideas in essentials, and at the same time have also afforded some further points of confirmation relative to external factors, which imply these processes of differentiation with regard to adaptation.‡

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* Sonderabdruck aus der Festschrift für J. Rosenthal., Leipzig, 1906.

† "Gibt es tatsächlich Arten, die heute noch in der Stammesentwickelung begriffen sind?" (Biol. Centralbl. xxi. nr. 22, u. 23).

‡ See my book also on this, 'Die moderne Biologie und die Entwickeungstheorie' (Freiburg, i. B. 1904), pp. 214–215.

The sooner the adaptation of *Dinarda* to *F. exsecta* and *rufibarbis* has taken place in a region, the more they are protected, through local isolation of the ants' nests in question from those of allied species of *Formica* (especially of *F. sanguinea*), so much the further has also the differentiation of the forms of *Dinarda* in question progressed.

This is most clearly shown, as yet, in the differentiation of *D. pygmæa* from its ancestral form *dentata*.

Also as regards *D. hagensi*, some new facts have been added in the last few years, which show that its adaptation to *F. exsecta* is not yet completed, but that in different points of its area of distribution it stands at different stages in the process of species building. Donisthorpe* found a number of *Dinarda* with *F. exsecta* at Bournemouth (county of Dorset, South England), which comes nearer to the typical examples taken by Von Hagens in the Siebengebirge in 1855 than the *Dinardas* taken by me at Linz on the Rhine with the same ant in 1893–1901. Most of these English examples show, just as Von Hagens's type, no raised keeled border to the elytra, but these organs are regularly arched, in which these examples even depart from the generic diagnosis of *Dinarda* ("elytrorum margine laterali carinato"). Also, the antennæ are shorter and more compact than in *D. dentata*. On the other hand, the border of the elytra in the examples from Linz is distinctly raised and keeled, and the antennæ are somewhat more slender than in *dentata*. In some of Donisthorpe's examples from England transitions between both the *hagensi* forms are noticeable in that the border of the elytra is sometimes feebly raised, and the antennæ are less compact. *Dinarda hagensi* has evolved, at different points of its area of distribution, as far as different stages towards a peculiar form; further, according to the specimens found up to the present, it has made the greatest progress in the Siebengebirge, in the Rhine Provinces, and in South England, which during "diluvial" times remained free from ice, and represents the oldest district for the adaptation of this *Dinarda* to *F. exsecta*. Should the process of differentiation which separates *D. hagensi* from *dentata* make still further progress elsewhere, then *D. hagensi* could not be included any more in the generic diagnosis of *Dinarda*, since the keeled border of the elytra of the latter has hitherto been regarded as essential. We must even define the whole group of *Dinardini* differently, since that keeled border of the elytra formed its most essential character! It has been objected by some defenders of the "constancy theory" that the previous observations on *Dinarda* offer no evidence on behalf of the evolution theory, since here it is only the question of evolution "within the species." In fact, it is perhaps better to reckon, as I showed more completely in 1896,* our four two-coloured *Dinarda* forms as races, rather than as species in the strictest systematic sense. But, in any case, they offer races, which stand at different stages in their evolution; *D. dentata* and *märkeli*, as far as concerns their constancy, have arrived much nearer to "true species" than *D. hagensi* and *pygmæa*. Further, indeed, as has been shown above, the keeled border of the elytra in the typical *D. hagensi* has disappeared; but when in this evolution a character can disappear, which has hitherto been held as essential, not only for the species but even for the genus in question, even for the whole group of genera, then the objection that it is only a case of evolution within the species will fall to the ground.

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* "*Dinarda hagensi*, Wasm., a species of Myrmecophilous Coleoptera new to Britain" (Entom. Record, 1905, pp. 181–182). Donisthorpe sent me examples of these *Dinardas*.

Let us now consider a similar process of differentiation, such as is the case which has furthered, and is still furthering, the evolution of our two-coloured forms of *Dinarda*, through the adaptation to different species of the genus *Formica*, extended to the adaptation of allied *Dinardas* to ant-guests of different genera and subfamilies. In this case, too, we get a phylogenetic understanding for the differentiation of the genera *Dinarda* and *Chitosa*. *Dinarda nigrita*, which occurs in the Mediterranean province, which Cassey has lately raised to the new genus *Chitosa*, is in the highest degree probably sprung through the adaptation of a *Dinarda*-like ancestor to the Myrmicide *Stenamma* (*Aphænogaster*) *testaceopilo-nigrita*, which is the actual host of *Chitosa nigrita*. The same essential differentiation process that we find in the evolution of *Dinarda* also takes place here, only that it already

* "*Dinarda*-Arten order Passen" (Wien. Entom. Zeitung, xv. 4 und 5, Heft. pp. 125–142).

began at an earlier date, and has attained, owing to the great difference of the hosts, the genera *Formica* and *Stenamma*, a much greater divergence between the adaptation forms in question. The same thing can also be shown for the tropical genera *Fauvelia* and *Allodinarda*, Wasm.

As I have previously remarked, it would be certainly wrong to conclude that the evolution of new species and genera has been effected in other ant-guests and Termite guests along the same path of a quite gradual variety-and-race-evolution, as in *Dinarda*. For the guests of the protected type, to which *Dinarda* belongs in a great measure, other biological principles of adaptation are in force than for the guests of the Symphile type (=relations of friendship) and the mimicry type. Together with the fluctuating variation we must always take into consideration the possibility of the building of new forms through mutation. Without entirely excluding Natural Selection, I believe further, in the case of guests of the Symphile type, we must attribute* great weight to Friendly Selection as a factor in evolution.

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* See on this 'Biologie und Entwickelungstheorie,' 2 Aufl. 9 Kap., especially pp. 219 ff., 230, 259 ff.

NOTES AND QUERIES.

AVES.

Domestication of the Jackdaw.—About the middle of June, 1907, I brought home two young Jackdaws from a neighbouring village, which were allowed their liberty about the place with uncut wings, and only shut up at night. At the time of the autumn migration their habits became rather erratic, so that sometimes we did not see them for two or three days at a time, and on November 9th we had what we thought was the last visit from one. However, on January 14th we were surprised to see him return, none the worse for the sharp frost, which must have made food difficult to obtain. He was as tame and friendly as ever, perching on the arm of his mistress and feeding from her hand, and up to the present (January 21st) he has come back every morning, going away at night. It would have surprised us less had he appeared at the return migration in March or April, and there is a record in the 'Birds of Norfolk' (vol. i. p. 279) of a Jackdaw which returned after nearly a year's absence, coming to the call of the boy who used to feed it, and settling on his shoulder. Certainly there are no bird-pets to compare with full-winged Jackdaws for tameness and sociable habits; these two birds, for example, would accompany my daughters and their dogs for long walks about the fields and meadows, and spend hours with us in the garden, where their attentions to fruit and flowers were not always of a desirable nature. But at the same time there are no pets more likely to be lost.—Julian G. Tuck (Tostock Rectory, Bury St. Edmunds).

Bean-Geese on the Dee Marshes.—As there appears to be some doubt as to the occurrence of the Bean-Goose (*Anser segetum*) on these marshes, it may be worth recording that on January 22nd last I saw a "gaggle" of fifteen of this species near Puddington. The difference between this bird and the Pink-footed Goose (*Anser brachyrhynchus*) was very apparent with the aid of a telescope at a reasonable distance. Compared with the Pink-footed—of which there are large numbers annually on the salt-marshes—the Bean-Goose is considerably less wary, and is apparently a more silent bird both on the wing and on the ground. I walked towards them for some distance in the open before they took wing, which they did without uttering a sound.—S. G. Cummings (Upton, Chester).

American Wood Duck in Oxfordshire. — In the last number of 'The Zoologist' (p. 33) it is suggested that the specimen of *Æx sponsa* shot in Oxfordshire might possibly be a wild one. We have large flocks both of *Æx sponsa* and *Æx galericulata*, which have never been pinioned, and the former have bred here for years. Woburn is about twenty-five miles "as the crow flies" from Oxford. M. Bedford (Woburn Abbey, Woburn).

The Smew in Northumberland.—A male of this species (*Mergus albellus*) in fine plumage was shot in the neighbourhood of Colt Crag, North Tynedale, Northumberland, in December, 1907.—J. S. S. Walton (Sunniside, Stocksfield-on-Tyne).

Ornithological Records from Chester and North Wales.—1. Siskin, female (*Chrysomitris spinus*); Hoole, near Chester, Dec. 15th, 1906.—2. Fork-tailed Petrel (*Oceanodroma leucorrhoa*); Ellesmereport, near Chester, Dec. 16th, 1907.—3. Common Bittern (*Botaurus stellaris*); Stoke, near Chester, Jan. 28th, 1908.—4. Red-throated Diver (*Colymbus septentrionalis*); Corwen, Nr. Wales, Jan. 7th, 1908. — Alfred Newstead (Grosvenor Museum, Chester).

Wildfowl in Somerset.—The following notes from my own observations made lately in Somerset may be of interest:—On Jan. 9th there were plenty of Gulls (*Larus ridibundus*) inland on the flooded fields near Yatton Station. On Jan. 9th, a cold frosty morning, I noticed the following birds in Sand Bay, north of Weston-super-Mare:—Mallard and Duck, twelve; Sheld-Duck, quite five hundred, scattered in parties over the Bay (this species has certainly increased of late years in the district); Scaup-Duck, a flock of about one hundred and fifty; Pochard, one drake; Curlews, about two hundred; Redshank, three; Ringed Plover, about thirty; Dunlin, a large flock of one thousand or more. There were also many Gulls about, chiefly *L. canus* and *L. ridibundus*. On Jan. 15th Scaup and Sheld-Duck were still in the bay in large numbers, and another flock of about two hundred Scaup were feeding in Weston Bay. This species is a regular winter visitor to the Bristol Channel, the flocks including a large number of adult drakes, conspicuous, through a strong glass, owing to their grey backs and white flanks. On Jan. 15th I went to the Bristol Waterworks Company's new reservoir at Blagdon, completed about eight years ago. This fine sheet of water, which, except for the dam, looks like a natural lake, extends for a mile and three-quarters in a valley to the north of the Mendip Hills. When the lake is full the surface area is four hundred and fifty acres. In places the water is very shallow, but the maximum depth is thirty-seven feet. I expected to find this reservoir a good resort for wildfowl, and was not disappointed. Tufted Ducks, to the number of at least two hundred, were busy diving in twos and threes, and little parties of twenty or thirty all over the water, a good proportion being adult drakes in full plumage. The birds were rather restless and often on the wing. Pochards were perhaps a little more abundant than the Tufted Ducks. Coming rather suddenly on a sheltered bay, I counted one hundred and fifty of this species resting, with other waterfowl, in a compact flock on the water. They were not very shy, merely swimming quietly out a little way into the lake, and returning to doze as soon as I had passed. Besides this flock many other Pochards were scattered over the water. A splendid adult drake Golden-eye followed by a duck kept well out in the rough water, and was continually diving. There were also a good many Mallard about, and a fair number of Wigeon and Teal, all very shy and probably lately shot at, but I could only make out two Shovelers, both fine drakes. A bird which must have been a female or immature Smew puzzled me for a long time. It was perhaps the shyest bird upon the water, and kept out of easy range of my glasses. The throat and neck showed white, and during flight there were very conspicuous white markings visible on the wings. Coots might be seen in hundreds, perhaps in thousands. They were everywhere, and mingled with the other fowl. I also noticed two Herons. A strong south-west breeze was blowing, ruffling the water considerably, but many of the Diving Ducks seemed to like the rough water. I am told on good authority that other species, such as Grebes and Divers, have been seen on the water, and that Shovelers and Tufted Ducks have been known recently to remain to breed by the lake. In winter twelve guns are said to have shot two hundred Duck, chiefly Teal, in one day. The lake, already famous for its big Trout, is evidently a very interesting bird resort, and is worthy of the attention of naturalists.—F. L. BLATHWAYT (Lincoln).

Distinct Types in Eggs.—In 'The Zoologist' (*ante*, p. 30) I have read with interest the article on "Eggs of the Red-backed Shrike," which is a reply to a previous note on the same subject. My limited experience leads me to agree with Mr. Bunyard. For years I had the run of a large Black-headed Gullery (*Larus ridibundus*) in Perthshire. Year after year in the *same* part of the moss we used to look for and find the exact same type of eggs—such as spotless blue and beautifully zoned eggs. We always held these were the production of the same female. In 1903 I picked up a clutch of two almost spotless blue eggs, slightly malformed. Returning to the same spot in 1904, I again got a clutch of two eggs of the exact same type, and also slightly malformed. Both clutches I still have, which to my mind proves them to be the product of the one bird. Speaking to one of the St. Kilda men about a specially fine Puffin's egg, he told me that this same type of egg (and only one egg) was laid each year in the same burrow. I could give many other instances, but do not wish to trespass any further on your space. — T. THORNTON MACKEITH (The Hall, Caldwell, Renfrewshire).

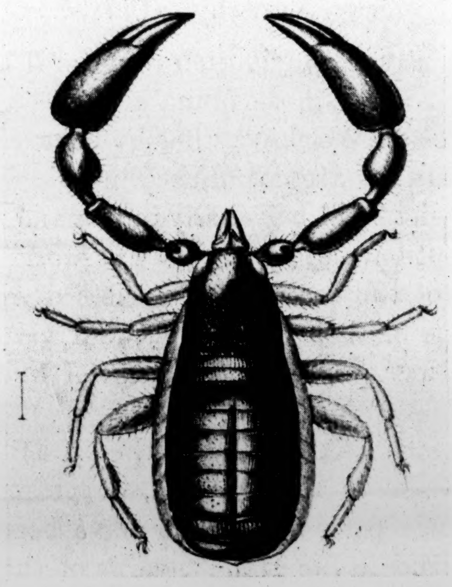
Some Ornithological Notes from Mayo and Sligo.—This has been the first season since 1898 that *Motacilla alba* has not been observed visiting the Island of Bartragh on their spring journey to the northern breeding haunts. However, I have no doubt but that they did pay their usual visit to rest and feed, though sometimes, as they remain only a few hours, it is possible that during their short stay they escaped the notice of Captain Kirkwood and his man, who always keep a good look-out for these birds during the migration time, the end of April and beginning of May. When they visit the island they are always to be met with on and about a marshy pasture near the shore situate between the garden and the sandhills, sometimes in the garden and a field close by, but their favourite haunt is the marshy pasture. If northerly or north-easterly winds prevail at the time of their visits their stay is prolonged for a day or two until the wind moderates. The birds generally appear in little flocks of four or five individuals, on different dates, and leave and are replaced by others. In the season of 1898 there were four separate arrivals and departures, one pair of the last party of visitors remaining until the end of May, and the late Mr. A. C. Kirkwood, expecting and hoping they would remain to nest, was much disappointed by their leaving the island as the others did. In 1906 there were four arrivals on separate dates. Captain Kirkwood observed two birds on May 1st, but they remained only a few hours. On the 5th six appeared, out of which he obtained a pair for me. This little flock disappeared next day, but was replaced by four birds on the 9th, and were joined by another bird on the 10th, when I had the pleasure of seeing and watching them for nearly an hour as they ran about and fed on the marshy flat adjoining the Rabbit-burrow. This lot also left that evening or next morning; but afterwards a few other birds were observed by Captain Kirkwood on the 12th and 13th, the last visitors for the season. No large flocks have ever been noticed, and the unusual number of fifteen has been only once observed by the late Mr. A. C. Kirkwood, on May 12th, 1898. Our small birds—Chaffinches, Green Linnets, and Yellowhammers—as usual, disappeared this autumn. I believe they began leaving in August, for on Sept. 1st no Chaffinches were about this place, and by Oct. 1st none of these species were to be seen anywhere about the district. It was not until Nov. 12th that any of the strangers put in an appearance here, when I observed about thirty birds in one of my fields; but no doubt the large migratory flocks had arrived inland some time previously, because for some days or weeks after their arrival they keep flocked together before dispersing over the country, and replacing the home-bred birds in the usual haunts. In the last week of November I noticed that the strangers had assembled in numbers about the stubbles and stackyard here, and about eight or ten days later I remarked that all through the district the birds had settled down, Chaffinches being especially numerous. With regard to the swimming birds and waders, Curlews did not appear to be as numerous as last season, and the Lapwings far less; while Golden Plover occasionally appeared in very large numbers, quite as numerous as last season. Wigeon appeared in their usual numbers, and during the few nights' frost the first week of the New Year very large numbers assembled in the estuary. But the Wild Ducks did not leave their inland haunts; very few were down, because the frost was not severe enough to drive them from the bogs and lakes. On only two nights was the mercury down to twenty-five degrees, and unless there are at least ten degrees of frost very few Mallards come down to the estuary.—Robert Warren (Moy View, Ballina).

Wood-Pigeon Diphtheria.—Much public interest has been shown lately in the disease of which Wood-Pigeons have been dying so freely this winter. The subject is of considerable scientific interest; moreover, it is quite possible, although it has not yet been absolutely proved, that this disease, which is most infectious amongst Wood-Pigeons themselves, may also be contracted by other birds, especially game-birds. It is of great importance, therefore, to find a means of stamping out the diphtheria. Before, however, any effective means can be taken to eradicate the disease it is necessary to discover its origin. To the January issue of 'British Birds' Dr. C. B. Ticehurst, of Guy's Hospital, contributed an article on the subject of Wood-Pigeon diphtheria, and explained that it was due to a specific micro-organism called *Bacillus diptheriæ columbarum.* At the same time Dr. Ticehurst pointed out that the etiology of the disease is most incomplete, and that much has to be learnt as to how it originates, when it comes, and as to its distribution before we can suggest a remedy. The Wood-Pigeon disease forms an excellent case for a systematic inquiry all over the country, and many schedules of the questions to be answered have been posted. Much information and many specimens have thus been received, but more of both are needed, and I should be delighted to supply schedules to any of the readers of 'The Zoologist' who may be in a position to give information on the subject. All the observations will be collated and studied by Dr. Ticehurst, who will draw up a full report at a later date.—H. F. Witherby (326, High Holborn, London).

A Correction: 'Vertebrate Fauna of North Wales.'—In my recently issued book there is an unfortunate printer's error on p. 222 which exactly reverses the meaning of the sentence, making me state that the Buzzard is double-brooded. The passage as I wrote it ran thus: " The Buzzard *never* rears two broods in a year, *but* like most birds," &c. All readers who have copies of the book are earnestly requested to make the correction.—H. E. Forrest (Hillside, Bayston Hill, Shrewsbury).

ARACHNIDA.

Curious Habit of a Chelifer. — My friend H. W. Bell-Marley recently sent me from Natal two specimens of a species of *Chelifer* which he had found firmly attached to the principal vein of the wings of a large Longicorn beetle (*Macrotoma natala*). It need scarcely be mentioned that the wings are membranous, and quite different to the strong elytra which cover them. Another species of *Chelifer* about



the same size but distinct from the one here figured has been described by C. J. With, of Copenhagen (Ann. Mag. Nat. Hist. xv. p. 123 (1905)), as *C. equester*, of which eight females and thirteen males were found beneath the elytron of a beetle (not identified) at Tavieta, Kilimanjaro. Some of the smaller species of the Pseudoscorpionidæ have been seen clinging to the legs of flies, a habit generally considered as denoting a convenient means of transport from place to place rather than an intention of preying on the flies themselves; but these specimens from Natal are much larger, and must prove a considerable inconvenience and annoyance to their hosts. The specimen here figured measures 5½ millim. in length of body, and is apparently an undescribed species, but being in a dried condition is not suitable for specific diagnosis.—W. L. Distant.

NOTICES OF NEW BOOKS.

The Vertebrate Fauna of North Wales. By H. E. Forrest. Witherby & Co.

This book is a real contribution to natural history, and pertains to a British area whose fauna required the historian. A number of papers on Welsh ornithology have recently appeared in our pages, and they are not unused in this volume; we hope that 'The Zoologist' will be equally in demand for records when a volume on South Wales appears. The work commences with short obituaries of the deceased zoologists of North Wales, and portraits of many of them give a peculiar value to the pages, while a good bibliography of the writings of living naturalists is also compiled.

Of the mammals, we read that at the present time 41 species are known to occur in North Wales, 8 became locally extinct within the historic period, while 15 have been identified only from remains found in limestone caverns of the prehistoric era. No list of mammals for North Wales had previously been published save that by Eyton in 1836.

Two hundred and seventy-two species of birds are enumerated;

of these 22 are recorded on doubtful evidence, 93 are residents, 52 winter visitors, 38 summer migrants, 17 chiefly occurring on passage in spring and autumn, 47 have occurred accidentally, and 3 are extinct locally; 143 have been known to breed in the district. The Reptiles and Amphibians are naturally not numerous, but 159 species of Fish are enumerated—27 fresh-water and 132 marine.

It will be evident from the above figures that Mr. Forrest has had to deal with a fair-sized vertebrate fauna, and he seems to have scarcely let a record slip the meshes of his net, supposing such a record to bear the imprimatur of authenticity. We have not made a microscopical search for errors, nor have we found any; one of the printer is corrected by Mr. Forrest himself in this issue (*ante*, p. 77). But we have looked for facts, and abundantly found them, analysed and well arranged. The book is embellished with a number of plates illustrating the haunts of different birds in North Wales, and it forms a notable addition to our now fast-increasing literature on faunal areas of Britain.

Birds of Britain. By J. Lewis Bonhote, M.A., F.L.S., &c.
Adam & Charles Black.

In a literary sense no naturalist is so well catered for as the British ornithologist, or the individual who is interested in British birds. Book follows book, one author inspires another, the supply is recurrent, and of course the standard is not always the same. Mr. Bonhote's volume, as might be expected, is not an ordinary compilation; it naturally does not reach the high-water mark of the late Mr. Howard Saunders's phenomenal condensation in his universally known 'Manual,' but it possesses originality and charm. It contains notes and observations which have "been taken at first-hand straight from Nature," and it is illustrated by one hundred coloured plates selected by Mr. H. E. Dresser from his 'Birds of Europe.' These features will alone distinguish the publication from many other works on the same subject, and make it an occupant of our shelves. Here at last is a book which will provide another judicious presentation to any lover of birds who would yet know more about them.

Guide to the Specimens of the Horse Family (*Equidæ*) *exhibited in the Department of Zoology, British Museum* (*Natural History*). Printed by order of the Trustees of the British Museum.

Although no name appears on the title-page, we read in the preface that this "Guide-Book" is the work of Mr. R. Lydekker. It is, however, more than a guide-book, and is practically a short but condensed memoir on the *Equidæ*, and as such is a publication to be remembered by students of the family. The National Collection now contains the skulls and some other parts of the skeletons of many of our celebrated thoroughbred racehorses, and their pedigree and performances are detailed in this small publication. This is a very welcome sign of the times, and a proper purview of a national and legitimate sport from the point of both the naturalist and the true sportsman is more likely to favour racing and the racehorse than the presence of mobs of gamblers at some plating saturnalia. We hope that the Museum will obtain many more of these trophies incidental to a national pastime and the improvement of man's noblest domestic mammal.

These pages are illustrated by twenty-six figures, and the cost of the publication is trifling.

Records of the Indian Museum (*a Journal of Indian Zoology*). Calcutta.

The Indian Museum at Calcutta has now followed the example of most of our Colonial Museums and those of other countries by publishing its own Journal. Parts i.–iii. of vol. i. have now reached us, and from the contents these 'Records' will be recognized as of considerable zoological importance. There is also an accompanying publication of a larger size, 'Memoirs of the Indian Museum,' the first part of which contains "An Account of the Rats of Calcutta," by Dr. W. C. Hossack, which is beautifully illustrated by coloured and other plates.

These publications reflect the energy of Dr. Annandale, the Superintendent of the Zoological Section of the Calcutta Museum.

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